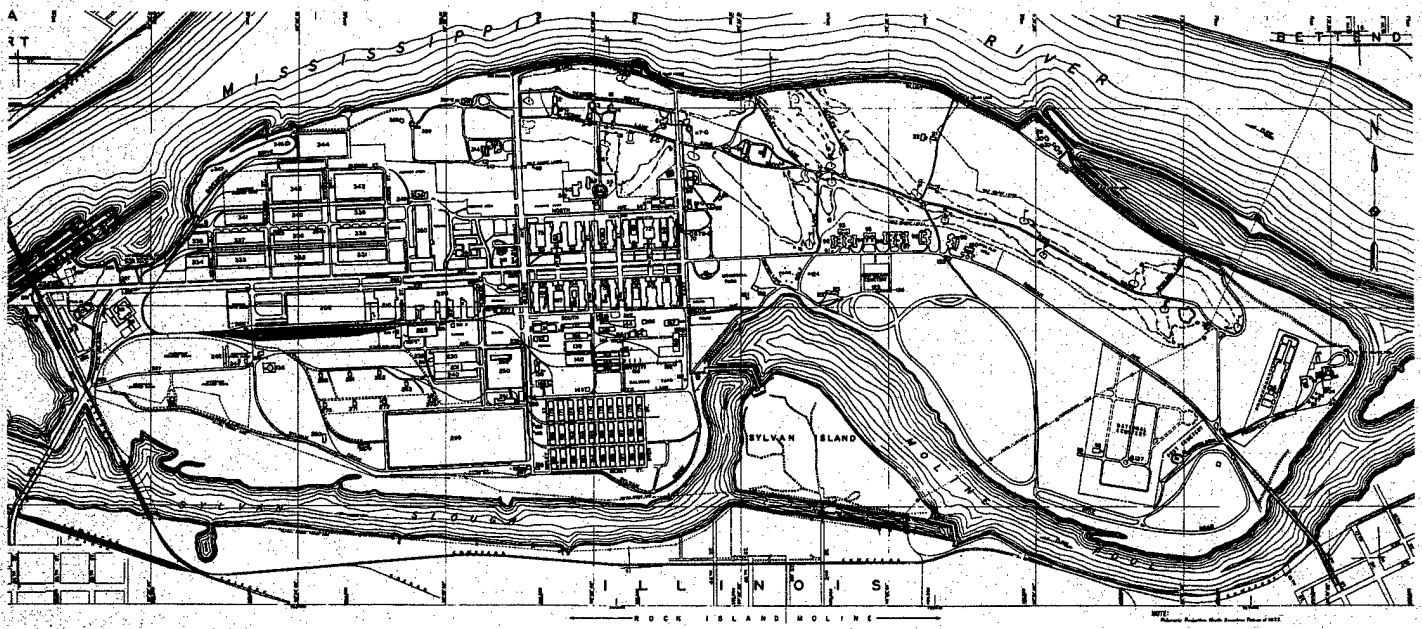
ENERGY ENGINEERING ANALYSIS PROGRAM
FINAL REPORT – INCREMENTS A, B, F AND G

VOLUME 1 – EXECUTIVE SUMMARY

U. S. ARMY
ROCK ISLAND ARSENAL, ILLINOIS



PREPARED FOR:
U. S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

PROJECT A1-30-10
CONTRACT NO. DACA45-80-C-0091

November 1983

PREPARED BY:

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ROCK ISLAND ARSENAL

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Prepared by

GARD, INC.
Niles, Illinois 60648

For

Department of the Army
Corps of Engineers
Omaha District

November, 1983

PREFACE

This Final Report summarizes all of the work accomplished under Increments A, B, F and G of the Energy Engineering Analysis Program conducted at Rock Island Arsenal. The tasks assigned under each Increment have been completed and are documented within.

The study objective was to develop a systematic plan of projects that would result in the reduction of energy consumption in compliance with the Army Facilities Energy Plan (AFEP) and to prepare Project Development Brochures (PDB's), DD Forms 1391 and supporting documentation for those projects deemed feasible. The projects developed as a result of this study are described in this report. Project Development Brochures and DD Forms 1391 have been prepared in accordance with Army procedures and are bound separately.

GARD has sincerely appreciated the cooperation that has been extended by members of the Omaha District, Corps of Engineers especially the Program Managers, Mr. S. Owens and Mr. E. Liu, and the Facilities Engineering staff of RIA headed by Mr. H. O. Lewin.

The GARD project team that conducted this study included M. Hormann, K. Spaulding, C. Schafer, N. Leslie, R. Hedrick and M. Hagen.

Respectfully submitted,

R. H. Henninger, P.E.
Project Engineer

Approved by:

P. A. Saigh, P.E.
Director, Government Programs

ADDENDUM TO FINAL REPORT

The reader's attention is directed to the following which has taken place since submittal of the Advanced Final Reports for Increments A, B, F and G.

1. In response to Revised ECIP Guidance issued 12/31/82, the Omaha District, Corps of Engineers has reviewed and revised all of the ECIP calculations for each of the eight qualifying projects for which PDBs and DD 1391s have been prepared. Appropriate changes have been made in pertinent sections of the Project Development Brochures and DD Forms 1391 only. All of the ECOs that are part of ECIP Projects No. A-1, A-2, A-3, A-4, A-5, A-6, B-1 and B-2, still qualify when evaluated under the new ECIP guidelines. The Main Report as well as the Executive Summary have not been revised to include the new SIR calculations.

EXECUTIVE SUMMARY
ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)
INCREMENTS A, B, F AND G
ROCK ISLAND ARSENAL

Authorization for Study

This Energy Engineering Analysis Program (EEAP) for Rock Island Arsenal was conducted under Contract No. DACA45-80-C-0091 issued by the Omaha District, Corps of Engineers to GARD, INC., Niles, Illinois on the 13 August 1980. The Scope of Work was structured into work increments with Increments A and B authorized under the original contract, Increment G authorized under Modification 1 dated 3 March 1981 and Increments B (expanded EMCS), D and F authorized under Modification 2 dated 20 May 1982.

Objectives and Scope

As stated in the EEAP Scope of Work the overall objectives were:

a) "Develop a systematic plan of projects that will result in the reduction of installation energy consumption in compliance with the Army Facilities Energy Plan."

b) "Develop Coordinated Basewide Energy System Plans."

c) "Prepare Project Development Brochures (PDBs), DD Forms 1391 and supporting documentation for all feasible energy conservation projects."

The Scope of Work further defined the objectives and scope of each work increment to be as follows:

Increment A - ECIP* Projects for Buildings and Processes

*ECIP - Energy Conservation Investment Program

Increment B - ECIP Projects for Utilities, Energy Distribution Systems and Energy Monitoring and Control Systems (EMCS)

Increment C - Renewable Energy Systems Projects

Increment D - Cogeneration and Solid Waste Plants Projects

Increment E - Central Boiler Plant Projects

Increment F - Facilities Engineer Conservation Measures

Increment G - Projects Identified in Increments A and B that do not qualify under ECIP criteria

This submittal presents the final results for Increments A, B, F and G through a description of those energy conservation opportunities (ECOs) and ECIP projects that were identified and evaluated as part of these work increments. Increments C, D and E have not been authorized at this time for Rock Island Arsenal.

Approach

Numerous retrofit modifications referred to as energy conservation opportunities (ECOs) were identified for each building, system, and central plant studied. Each ECO was evaluated separately using the life cycle costing method described in the ECIP guidance included as Annex F of the AFEP. Energy savings were determined for each ECO and life cycle benefits were calculated using current mid FY82 fuel costs, which were escalated over the expected life of the modification. Implementation or construction costs were also determined using current FY82 cost data which were escalated to the midpoint of construction assuming an FY86 project award date. Comparison of ECOs was done on the basis of energy-to-cost (E/C), benefit-to-cost (B/C), and simple amortization period (SAP) ratios in accordance with ECIP criteria. Qualifying ECOs were grouped into ECIP projects under the guidance of the

Facilities Engineering Staff. Then, once adjustments were made for any interactive or synergistic ECO effects which were present within an ECIP project, the PDB and DD Form 1391 were prepared for each ECIP project. Non-qualifying ECOs became candidates for implementation as an Increment G project.

Facility Description

Rock Island Arsenal (Figure 1), a government owned and government operated (GOGO) facility, is situated along the western border of Illinois on an island within the Mississippi River. It has mission responsibility for the production, repair and rebuilding of various Army vehicles, artillery and small arms. In addition, several tenant activities occupy various administrative areas including the United States Army Armament Materiel Readiness Command (ARRCOM) Headquarters. Officer's quarters and military housing is provided for ARRCOM headquarters staff personnel.

The installation includes 214 buildings, some over 100 years old, with the total gross square footage of floor area equaling 6,676,634 square feet. The buildings range in construction from heavy stone, to concrete, to wood frame. A total of 74 buildings (Table 1) representing some 5,000,416 square feet were identified for study under this contract. These buildings constitute the majority of those which are actively occupied.

The current population is made up of both resident and non-resident personnel totaling about 8,500. This level is not expected to vary significantly over the next five years.

Energy Distribution Systems and Central Plants

Rock Island Arsenal utilizes four primary forms of energy to support facilities operations: electricity, coal, natural gas and fuel oil. Electricity is used for lighting, heating, cooling, ventilation, manufacturing, process, security, etc. systems. Coal is utilized by the main central heating

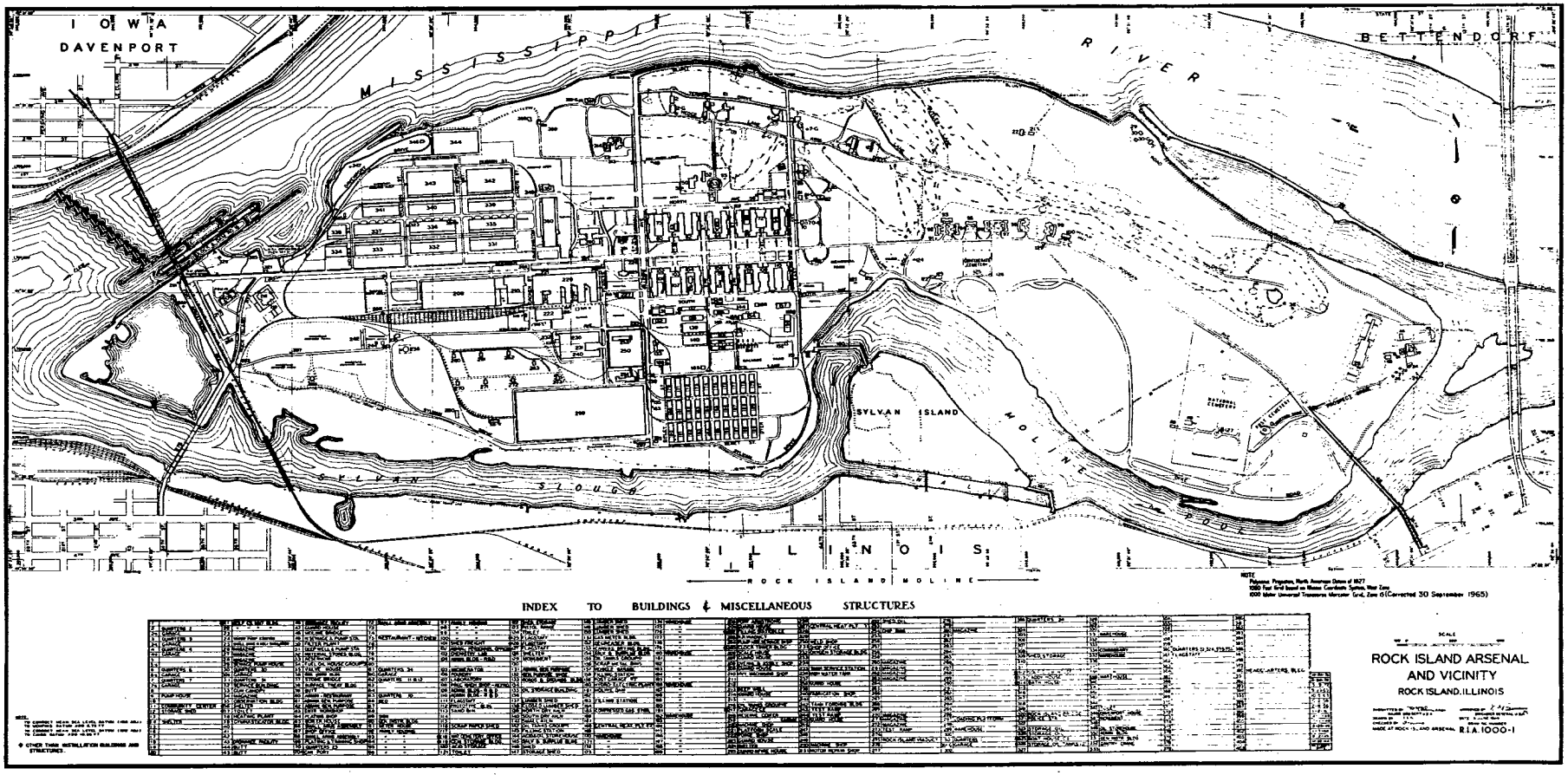


Figure 1 ROCK ISLAND ARSENAL SITE PLAN

TABLE 1
BUILDINGS IDENTIFIED FOR EEAP STUDY

Building No.	Title	Function	No. Floors	Gross Sq. Ft.
2	Quarters 2	Housing	3	6,114
3	Quarters 3	Housing	3	7,580
4	Quarters 4	Housing	3	6,985
6	Quarters 6	Housing	4	8,310
7	Quarters 7	Housing	4	8,410
9	Pump House	Utility	1	1,900
11	Community Center	Institutional	2	9,912
25	Small Arms Range & Helicopter Simulator	Laboratory	3	48,282
30	Quarters 30	Housing	3	3,330
31	Quarters 31	Housing	3	2,918
32	Service Building	Service	1	2,985
34	Magazine	Storage	1	183
50	Water Treatment Plant	Utility	2	8,553
56	General Instruction Building	Training	4	56,480
58	Small Arms Assembly	Industrial	1	16,630
60	Administration/ Restaurant	Administration/ Institutional	4	159,789
61	Administration/ Credit Union	Administration	4	19,552
62	Administration- General Purpose	Administration	4	159,606
63	Entertainment Workshop	Special	1	2,625
64	Plating Shop	Industrial	1	44,335
65	Process Water Purification Plant	Industrial	1	5,920
66	Small Arms Assembly	Industrial	4	159,950
67	Shop Office	Administration/ Industrial	4	19,925
68	Small Arms Assembly	Industrial	4	161,382
69	Plating & Tinning Shop	Industrial	1	9,780
70	Quarters 23	Housing	3	1,973
72	Small Arms Assembly	Industrial	2	38,395
75	Cafeteria Kitchen	Institutional	1	21,161
81	Quarters 34	Housing	3	4,284
82	Quarters 11 & 12	Housing	3	3,360
86	Bachelor's Enlisted Quarters	Housing	1	4,416
90	General Instruction Building	Training	4	34,700
92	Family Housing	Housing	2	6,071
100	Family Housing	Housing	2	5,075
102	Administration/ Personnel	Administration	4	159,240
103	Administration	Administration	4	19,414
104	Administration	Administration	4	161,343
106	Foundry	Industrial	1	66,703
107	Storage Building	Storage	1	18,340

TABLE 1 (Con't.)
BUILDINGS IDENTIFIED FOR EEAP STUDY

Building No.	Title	Function	No. Floors	Gross Sq. Ft.
108	Reproduction	Special	4	159,620
109	Administration	Administration	4	19,570
110	Administration	Administration/ Training	4	161,637
131	Administration	Administration/ Laboratory	4	60,310
132	General Purpose Warehouse	Storage	1	7,644
133	Roads & Grounds Office	Service	2	5,003
139	Maintenance Shops	Service	1	28,800
140	Lumber Storage	Storage	1	27,506
144	Paints & Oils Storehouse	Storage	1	16,097
145	Salvage & Surplus Building	Storage	1	12,090
154	Salvage & Surplus Building	Storage	3	31,200
157	Vehicle Garage & Machine Shop	Service	3	21,408
159	Post Garage	Service	2	26,247
160	Hydroelectric Plant	Utility	1	20,986
204	Sewage Pump House	Utility	3	4,155
206	Scale House	Special	3	1,163
208	Heavy Machining Plant	Industrial	2	362,193
210	Manufacturing Plant	Industrial	4	113,440
220	Machine Shop	Industrial	5	536,970
222	Forge Shop	Industrial	1	37,678
225	Firehouse & Police Station	Service	3	8,588
227	Central Heating Plant	Utility	1	17,408
230	Production Building	Industrial	1	75,965
231	Production/Inspection Building	Industrial	1	22,400
235	Vehicle Service Bldg.	Service	1	1,965
240	Sheet Metal & Heat Treating Shop	Industrial	1	35,550
250	Machine Shop	Industrial	4	272,284
251	Battery Maintenance Building	Industrial	1	9,180
299	Warehouse	Storage	1	774,880
301	Quarters 1	Housing	4	19,205
333	Post Exchange	Institutional	1	12,432
334	Commissary	Institutional	1	17,591
350	Administration Bldg.	Administration	6	438,735
360	Quarters 32, 32A, 33 & 33A	Housing	3	13,760
390	ARRCOM Headquarters	Administration	5	150,845
		TOTAL		5,000,416

plant to generate steam for heating, cooling, manufacturing, process and prime mover systems. Natural gas is the source for heating of family housing and is also used for manufacturing and process systems. Fuel oil is utilized as a source of heating for certain remote buildings.

Various forms of energy, both purchased and/or generated, are distributed throughout the installation from site entry points or central plants to the end users which are typically buildings. Table 2 summarizes the energy distribution systems that are in use at RIA along with the central plants that supply these systems.

Energy Conservation Actions Since FY75

RIA has aggressively pursued an energy management program which has resulted in a reduction of 13.5% in overall energy consumption in FY80 compared to FY75 according to the RIA Installation Energy Plan dated 9/1/81. This effort resulted in RIA receiving DARCOM energy achievement awards in FY80. The list below summarizes the facility-related energy conservation modifications that have been performed since FY75.

- All thermostats for heating, air conditioning and hot water systems were reset in accordance with Army standards.
- All quarters and family housing units were insulated and equipped with storm windows. Some automatic night setback thermostats were also installed.
- High efficiency lighting systems were installed in two manufacturing buildings.
- Domestic hot water control systems were installed in six administration buildings to allow circulating pumps to cycle off during unoccupied hours.
- Steam supply to some 15 heavy construction type buildings not occupied during evenings or weekends are shutoff during unoccupied periods

TABLE 2
ROCK ISLAND ARSENAL
ENERGY DISTRIBUTION SYSTEMS AND CENTRAL PLANTS

Energy Form	Source	Distribution System	End User
Electricity	Iowa-Illinois Electric Co.	4 Primary Feeders @ 13.8 KV	1 Switching Station & 7 Substations
	Hydroelectric Plant (Bldg. 160), Capacity: 2800 KW	34 Primary Feeders @ 2.4 KV	Specific Loads (Buildings, Perimeter Lighting, Tenants, etc.)
Steam	Building 227 (CHP-1) Capacity: 410,000 LB/HR Fuel: Coal	Below Grade Pipes in Tunnels & Buried Pipes @ 150 PSI	51 Buildings in Administration & Manufacturing Complex
	Building 38 (CHP-2) Capacity: 32 HP Fuel: Fuel Oil	Buried Pipes @ 12 PSI	4 Buildings Located in Remote R&D Testing Area
Condensate	All Buildings Supplied with Steam from CHP-1 & CHP-2	Below Grade Pipes in Tunnels & Buried Pipes	Building 227 (CHP-1) Building 38 (CHP-2)
Natural Gas	Iowa-Illinois Gas Co.	From Gas Meter Building (Bldg. 151) via Underground Pipes @ 35 PSI	Quarters, Family Housing, Manufacturing Buildings & Process Loads
Compressed Air	Compressor Plant (Bldg. 220) Capacity: 16,000 CFM	Belowgrade Pipes in Tunnels & Buried Pipes @ 105 PSI	Manufacturing & Administration Buildings
Chilled Water	Building 348 Chiller Plant Capacity: 750 Ton Absorption	Closed Loop Supply & Return Piping	Buildings 350 & 390
	Building 62 Chiller House Capacity: 385 Ton Absorption	Closed Loop Supply & Return Piping	Building 62

when outdoor air temperature is above approximately 30°F.

- Individual heating controls were installed on perimeter heating systems in most administration buildings.
- Reduced wattage fluorescent bulbs are being used as replacements for standard 40 watt bulbs.
- An electrical demand controller has been installed to shed loads in Building 25 (Small Arms Range), Building 106 (Foundry) and Building 350 (Administration).
- Delamping has been performed in stairwells, corridors, and aisleways of all administration buildings.
- Numerous process energy related modifications have been made, e.g., scheduling operation of electric melt furnaces in Foundry.
- Several buildings have been vacated, shutdown and operations consolidated into other buildings.

Energy Conservation Studies

Since FY75, RIA has contracted for three studies that relate to energy conservation:

1. "Improve Lighting in Industrial Buildings 208, 220, 222"
   Contract No. DACA45-79-C-0018
2. "Exterior Electrical Distribution System Study"
   Contract No. DACA45-76-C00157
3. "Air Compressor Plant Study - Building 220"
   Contract No. DACA45-81-D-0161

The first two projects made recommendations for changes which would result in conserving energy. Portions of the lighting study have already been implemented. Upgrading of the electrical distribution system is programmed for FY86. The third study is in progress.

Historical Energy Data

Total annual facility-related energy consumption in terms of source energy for the installation for the years FY77 through FY80 is shown in Figure 2. Each form of energy has been converted to its heat energy equivalent to reflect source energy requirements. Comparison on an annual historical basis to FY75 consumption is shown in Table 3. In accordance with DARCOM requirements, generated electricity has been excluded from the analysis shown in Table 3 and results reflect total energy requirements at the raw source point.

The historical energy consumption can also be expressed in terms of energy use per gross square foot of floor area. Sometimes referred to as the energy use index (EUI), this factor is a measurement of an installation's performance and can be used to compare performance to other similar installations. Table 4 and Figure 3 summarize the EUI for RIA for FY75 through FY80. Except for FY79, the trend indicates a gradual but steady decline in EUI, i.e., improvement in energy utilization efficiency.

Actual costs for purchased electricity, natural gas and coal were obtained from RIA reports entitled "Data for Commander's Monthly Briefing." Results for the period from FY77 through FY80 were compiled and are presented in Table 5. Costs for purchased electricity include the demand charge. Unit costs for electricity including demand ran approximately $33.61 per megawatt-hour in FY79. Costs for generated electricity were determined based upon annual operation and maintenance costs for the hydroelectric plant and ran approximately $14.82 per megawatt-hour in FY79, a factor of 2¼ times cheaper than purchased electricity. Purchased costs for coal include delivery charges.

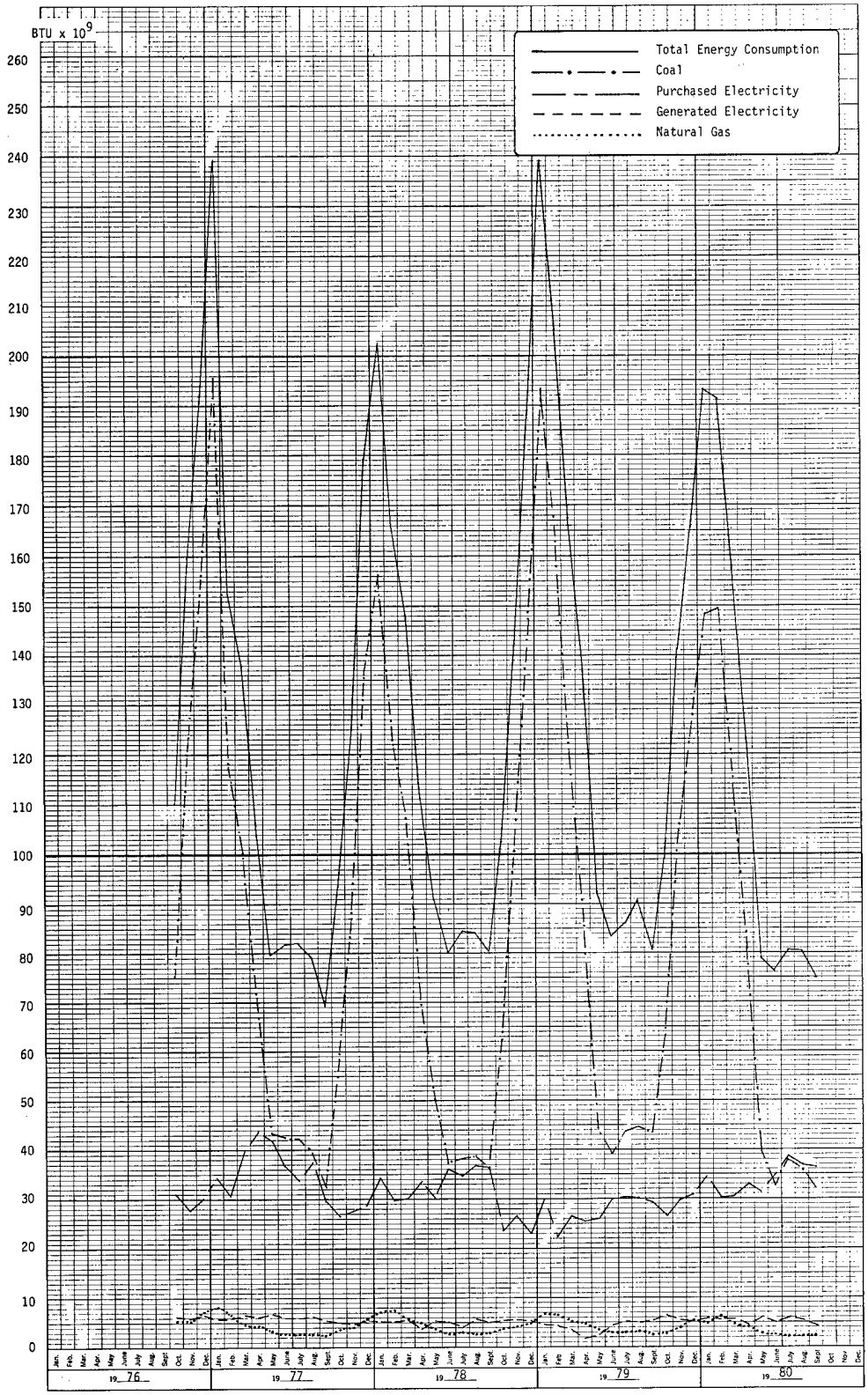


Figure 2 ROCK ISLAND ARSENAL
HISTORICAL SOURCE ENERGY CONSUMPTION

TABLE 3
ROCK ISLAND ARSENAL
COMPARISON OF TOTAL ANNUAL
FACILITY - RELATED PURCHASED ENERGY CONSUMPTION

Reporting Period	Electricity		Natural Gas		Coal		Total	
	MBTU	Change	MBTU	Change	MBTU	Change	MBTU	Change
FY75	405,768	--	69,389	--	1,001,707	--	1,476,864	--
FY76	381,721	- 5.9%	59,498	-14.3%	1,011,418	+1.0%	1,452,637	-1.6%
FY77	324,030	-20.1%	56,308	-18.9%	1,035,024	+3.3%	1,415,362	-4.2%
FY78	392,839	- 3.2%	54,242	-21.8%	938,961	-6.3%	1,386,042	-6.1%
FY79	415,975	+ 2.5%	51,358	-26.0%	1,092,851	+9.1%	1,560,184	+5.6%
FY80	384,466	- 5.2%	43,825	-36.8%	968,509	-3.3%	1,396,800	-5.4%

Notes:
1. FY75 and FY76 data taken from "Rock Island Arsenal Installation Energy Plan", 1 September 1981; remainder of data taken from "Data for Commander's Monthly Briefing".
2. Electricity includes purchased only, generated electricity excluded.
3. FY75 used as base year, (-) change indicates saving, (+) change indicates increase.
4. Results represent energy requirements at raw source energy point.

TABLE 4
ROCK ISLAND ARSENAL
HISTORICAL ENERGY CONSUMPTION
PER GROSS SQUARE FOOT

Period	Real Property Inventory* (1000 GSF)	Purchased Energy (MBTU)	Energy Use Index (KBTU/GSF)	% Change Compared to FY75
FY75	6,174	1,476,864	239.2	-
FY76	6,272	1,452,637	231.6	-3.2
FY77	6,246	1,415,362	226.6	-5.3
FY78	6,222	1,386,042	222.8	-6.9
FY79	5,949	1,560,184	262.3	+9.7
FY80	5,933	1,396,800	235.4	-1.6

*REF: FESA Report No. T-2108

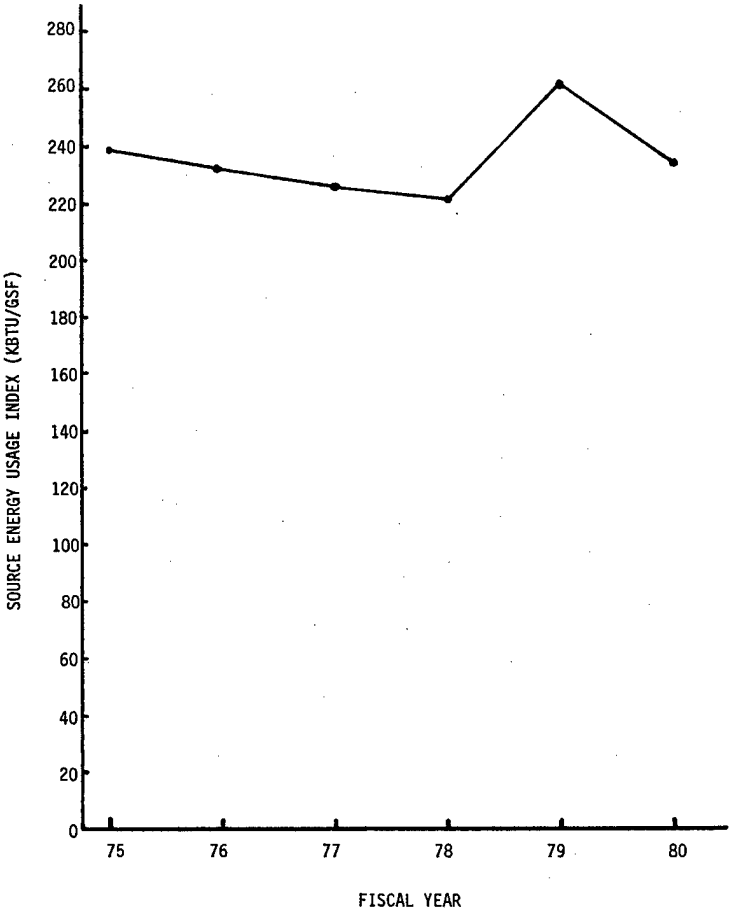


Figure 3 ROCK ISLAND ARSENAL HISTORICAL SOURCE ENERGY USE INDEX

TABLE 5
ROCK ISLAND ARSENAL
SUMMARY OF OPERATING UTILITY COSTS
FOR FY77 - FY80

Period	Electricity Purchased ($)	Electricity Generated ($)	Natural Gas ($)	Coal ($)	Total ($)	Estimated Operating Cost ** ($/SQ.FT)
FY77	814,084	176,572	93,078	1,056,233	2,139,967	0.343
FY78	1,018,622	220,836	94,011	1,480,403	2,813,872	0.452
FY79	1,205,785	232,946	115,004	1,597,547	3,151,282	0.529
FY80	1,195,972	326,271*	120,243	1,298,756	2,941,242	0.465

* Estimated based upon 14,157 MWH generated and FY79 unit cost rate plus 15% escalation

** Based upon real property inventory (FESA Report T-2108)

Building Energy Consumption Analysis

Little in the way of utility submetering is in use at RIA except for that installed in family housing, quarters, and certain tenant occupied buildings. Where metered data was available, this was used to establish a building's annual energy usage rate. Establishing annual energy usage rates for all other buildings was done using various analytical methods. Estimated annual energy consumption for all types of energy are summarized in Table 6 on a building-by-building basis for those buildings under study. Total energy consumption was calculated for each building by converting all units to BTU's and summing them for each energy type. An energy usage index was then obtained for each building by dividing the total energy consumption by the occupied floor area.

Summary of Recommended Projects

A brief description for each of the projects identified and evaluated under this Energy Engineering Analysis Program study is provided in Table 7. The funding requirements and energy and cost savings for each of these are summarized in Table 8. The projects presented in this table are listed in order of descending energy-to-cost ratios.

Implementation of all of the ECIP qualifying projects will require over $7.6 million in funding and yield a total annual energy savings of 338,000 MBTU. This energy savings figure is based upon each project being independent of the others, as per instructions from RIA personnel, and is exclusive of the effects of interactions between projects. Table 9 describes the degree to which interactions between projects will affect the energy savings credited to those projects. The projects listed as "independent" are assumed to be implemented first, the effect on each of the other "dependent" projects is

TABLE 6
ROCK ISLAND ARSENAL
ESTIMATED ANNUAL ENERGY CONSUMPTION SUMMARY

BUILDING DESCRIPTION	FLOOR AREA (SQ FT)	COAL (TONS) HEATING	COOLING	PROC.	ELECTRICITY (KWH) HEATING	COOLING	LIGHTING	PROCESS	NATURAL GAS (KCF) HEATING	PROC.	FUEL OIL (GAL)	TOTAL ENERGY (MBTU)	ENERGY USE INDEX
9 WATER PUMP HSE.	1900							315977	208			3880	2042.1
11 COMMUNITY CNTR.	9912						6607	10335	1392			1632	164.6
25 SMALL ARMS R/D	48282					56013	290150	314696			28981	11686	242.0
32 TESTING RANGE	2985						24270	6226			4256	944	316.2
34 MUNITION STOR.	183					549					370	58	316.9
50 FILTRATION PLNT.	8553	32.2					58240	473754				6963	814.1
56 INSTRUCTION	56480	65.5				34582	166137	63857				4679	82.8
58 METAL TREATMENT	16630	77.9		2.9			63110	70312				3463	208.2
60 RESTAURANT	159789	265.5				121768	740144	165431		680		19137	119.8
61 ADMIN: GENERAL	19552	13.1				11812	20911	26951				1014	51.9
62 ADMIN: GENERAL	159606	181.7	186.3				845430	251172				21767	136.4
63 BAND FACILITY	2625	26.5					12707	7200				882	336.0
64 PLATING SHOP	44335	472.4		4893.8			243972	179590				136825	3086.2
65 PLATING WATER	5920	68.8					7624	24990				2070	349.7
66 SMALL ARMS	159950	291.1		2.9			151212	1602758				27573	172.4
67 SHOP OFFICE	19925	60.1				6088	82594	132421				4042	202.9
68 SMALL ARMS	161382	291.5										7166	44.4
69 PLATING SHOP	9780	126.4					26261	41509				3893	398.1
72 SMALL ARMS	38395	198.9					175778	390101				11454	298.3
75 KITCHEN	21161	69.6					116479	134693				4625	218.6

1 TON COAL = 24.582 MBTU
1 KWH ELECTRICITY = 0.0116 MBTU
1 KCF NATURAL GAS = 1.031 MBTU
1 GAL FUEL OIL = 0.1387 MBTU
ENERGY USE INDEX = TOTAL MBTU X 1000 / FLOOR AREA

TABLE 6 (Con't.)
ROCK ISLAND ARSENAL
ESTIMATED ANNUAL ENERGY CONSUMPTION SUMMARY

BUILDING DESCRIPTION	FLOOR AREA (SQ FT)	COAL (TONS) HEATING	COOLING	PROC.	ELECTRICITY (KWH) HEATING	COOLING	LIGHTING	PROCESS	NATURAL GAS (KCF) HEATING	PROC.	FUEL OIL (GAL)	TOTAL ENERGY (MBTU)	ENERGY USE INDEX
90 INSTRUCTION	34700	150.8			66972		190999	57300				7364	212.2
102 ADMIN: GENERAL	159240	203.9					652285	250749				15487	97.3
103 ADMIN: GENERAL	19414	29.5					80477	30920				2017	103.9
104 ADMIN: R/D	161343	476.2			18265		572484	242873				21376	132.5
106 FOUNDRY	66703	1164.0		657.8			211781	7539402		8327		115833	1736.5
107 ADMIN: STORAGE	18340	80.0					33461	38968				2807	153.1
108 ADMIN: REPRO.	159620	177.3			34095		513865	229063				13372	83.8
109 ADMIN: R/D	19570	19.5					38120	31344				1285	65.7
110 INSTRUCTION	161637	176.6			73061		537591	207878				13836	85.6
131 ADMIN: GENERAL	60310	185.8			63319		286214	39082				9075	150.5
132 WAREHOUSE	7644	31.5					41933	16519				1452	190.0
133 ROADS & GROUNDS	5003	17.5					2923	4701				519	103.7
139 TRADES SHOPS	28800	282.7					32614	121986				8743	303.6
140 LUMBER STORAGE	27506	151.8										3732	135.7
144 OIL STORAGE	16097	83.0					87677					3057	189.9
145 SALVAGE STORAGE	12090	37.9					13978					1094	90.5
154 SALVAGE OFFICES	31200	105.9					73700	28802				3792	121.5
157 VEHICLE GARAGE	21408	65.6			9741		42558	645				2227	104.0
159 VEHICLE GARAGE	26247	175.0					33461	55487				5334	203.2
160 HYDRO. PLANT	20986						14825		5345			5683	270.8

1 TON COAL = 24.582 MBTU
1 KWH ELECTRICITY = 0.0116 MBTU
1 KCF NATURAL GAS = 1.031 MBTU
1 GAL FUEL OIL = 0.1387 MBTU
ENERGY USE INDEX = TOTAL MBTU X 1000 / FLOOR AREA

TABLE 6 (Con't.)
ROCK ISLAND ARSENAL
ESTIMATED ANNUAL ENERGY CONSUMPTION SUMMARY

BUILDING DESCRIPTION	FLOOR AREA (SQ FT)	COAL (TONS) HEATING	COOLING	PROC.	ELECTRICITY (KWH) HEATING	COOLING	LIGHTING	PROCESS	NATURAL GAS (KCF) HEATING	PROC.	FUEL OIL (GAL)	TOTAL ENERGY (MBTU)	ENERGY USE INDEX
204 SEWAGE DISPOSAL	4155							474389			2771	5887	1416.8
206 SCALE HOUSE	1163						11860	2541	213			387	332.8
208 ASSEMBLY PLANT	362193	1773.5		4.1			419326	978428				59911	165.4
210 MACHINE SHOP	113440	1383.4		3.2			482860	1126675				52756	465.1
220 MACHINE SHOP	536970	4294.7	180.3	54.0	58449		2880221	1296990				160466	298.8
222 FORGE SHOP	37678	877.9		6606.6			106738	2858195		4262		222771	5912.5
225 GUARD/FIRE HOUSE	8588	43.6					47439	18213				1833	213.4
227 HEATING PLANT	17408	135.8					55910	73700				4842	278.1
230 WELDING SHOP	75965	942.3					279551	521405		4582		37179	489.4
231 WELDING OFFICE	22400	144.2		4.1			106738	238465				7650	341.5
235 SERVICE STATION	1965						4744	2033	260			347	176.6
240 PRODUCTION SHOP	35550	584.4					127069	421020				20724	583.0
250 MACHINE SHOP	272284	1508.6		5.0			583668	348168				48017	176.3
251 REPAIR SHOP	9180	90.3					11860	77088				3252	354.2
299 MAIN WAREHOUSE	774880	1533.3			31660		562497	905569				55088	71.1
333 POST EXCHANGE	12432				19361		157989	58485			7219	3737	300.6
334 POST COMMISSARY	17591				30686		169001	1055801			11534	16163	918.8
350 ADMIN: OFFICES	438735	1166.1	311.1		286330		3904402	411365				89697	204.4
390 ARRCOM HDQTRS.	150845	650.9	229.6		14949		1112272	180357				36812	244.0

1 TON COAL = 24.582 MBTU
1 KWH ELECTRICITY = 0.0116 MBTU
1 KCF NATURAL GAS = 1.031 MBTU
1 GAL FUEL OIL = 0.1387 MBTU
ENERGY USE INDEX = TOTAL MBTU X 1000 / FLOOR AREA

TABLE 6 (Con't.)
ROCK ISLAND ARSENAL
ESTIMATED ANNUAL ENERGY CONSUMPTION SUMMARY

BUILDING DESCRIPTION	FLOOR AREA (SQ FT)	COAL (TONS) HEATING	COOLING	PROC.	ELECTRICITY (KWH) HEATING	COOLING	LIGHTING	PROCESS	NATURAL GAS (KCF) HEATING	PROC.	FUEL OIL (GAL)	TOTAL ENERGY (MBTU)	ENERGY USE INDEX
2 QUARTERS NO. 2	6114						20755	4132	439			741	121.2
3 QUARTERS NO. 3	7580						8927	2232	566			713	94.1
4 QUARTERS NO. 4	6985						10211	2553	638			806	115.4
6 QUARTERS NO. 6	8310						15255	3814	764			1009	121.4
7 QUARTERS NO. 7	8410						17451	7452	700			1011	120.2
30 QUARTERS NO. 30	3330						11013	2898	375			548	164.6
31 QUARTERS NO. 31	2918						9742	2137	320			468	160.4
70 QUARTERS NO. 23	1973						6777	2290	193			304	154.1
81 QUARTERS NO. 34	4284	18.8					10165	4755		54		691	161.3
82 QTRS. NO. 11,12	3360	16.7					11436	659		96		650	193.5
86 B. E. Q.	4416				82203		13723	38150				1555	352.1
92 FAMILY HOUSING	6071						36130	10911	566			1129	186.0
100 FAMILY HOUSING	5075						36850	2471	391			859	169.3
301 QUARTERS NO. 1	19205						21178	5295	1795			2158	112.4
360 QTRS. NO.32-33A	13760	54.4					46592	6039		248		2203	160.1

1 TON COAL = 24.582 MBTU
1 KWH ELECTRICITY = 0.0116 MBTU
1 KCF NATURAL GAS = 1.031 MBTU
1 GAL FUEL OIL = 0.1387 MBTU
ENERGY USE INDEX = TOTAL MBTU X 1000 / FLOOR AREA

TABLE 7
DESCRIPTION OF EEAP GENERATED PROJECTS

Project	Description
A-1/Reduce Window Area, Building 220	Removal of existing window, systems and installation of translucent insulating panels in Building 220.
A-2/Reduce Window Area, Buildings 230, 231, 240 and 390	Removal of existing window systems and installation of translucent insulating panels in Buildings 230, 231 and 240. Addition of translucent insulating panels to ½ the window area of Building 390.
A-4/Insulate Walls and Upgrade Windows	Insulate perimeter walls of Buildings 32, 133, 206, 350 and 390. Install storm windows on single pane windows of Buildings 50, 56, 90, 131, 154, 206, 210 and 225.
A-5/Install High Efficiency Lamps	Replace existing incandescent lamps with fluorescent lamps in Buildings 50, 131, 133, 139 and 154 and with high pressure sodium lamps in Buildings 208, 230 and 240.
A-6/Convert to VAV and Install Destrat. Fans	Convert multi-zone conditioning systems in Buildings 25, 56, 62, 333, 350 and 390 to variable air volume systems. Convert re-heat air conditioning systems in Buildings 350 and 390 to variable air volume systems. Install destratification fans in Buildings 220, 222 and 240.
B-1/Medium EMCS	An Increment B project consisting of a medium EMCS to provide automatic control and monitoring of HVAC systems in 27 buildings.
B-2/Modifications to Elec. and Steam Dist. Sys.	Convert street lighting to high pressure sodium lamps. Institute a steam trap inspection and replacement program.
F-1 to F-21/Low Cost Energy Conservation Projects	Various low cost facility modifications related to operation and maintenance activities.

TABLE 7 (Cont'd.)
DESCRIPTION OF EEAP GENERATED PROJECTS

Project	Description
G-1/Non-Qualifying ECOs for Buildings	Those ECOs identified under Increment A which do not meet ECIP criteria for E/C or B/C ratios.
G-2/Electrical Power Factor Correction	Installation of electrical power factor correction equipment in order to avoid reactive power demand charges.
G-3/Electric Submetering of Selected Buildings	Installation of electric consumption meters in Buildings 25, 56, 60/61/62, 75, 90, 102/103/104, 108/109/110, 131, 208, 210, 220, 222, 227, 299, 350 and 390.
G-4/Steam Submetering of Selected Buildings	Installation of condensate meters in order to monitor steam consumption in Buildings 56/90, 50/60/61/62/63/360, 102/103/104/106/107, 108/109/110/157/159, 208/210, 220, 222, 299, 350 and 390.
G-5A/Consolidate Clg. Sys. in Building 350 (Case I)	Retrofit cooling systems in Building 350 in order to supply cooling requirements with existing steam absorption chiller in Building 348. Install new steam absorption chiller to serve Building 390.
G-5B/Consolidate Clg. Sys. in Building 350 (Case II)	Retrofit cooling systems in Building 350 in order to supply cooling requirements with existing steam absorption chiller in Building 348. Install new centrifugal chiller to serve Building 390.
G-6/Increase Elec. Load Shedding Capability	Expand the capability of existing electrical demand limiter in order to connect and control additional sheddable loads in Buildings 9, 25, 50, 56, 62, 90, 106, 107, 131, 220, 299, 333, 334, 350 and 390.

TABLE 8
ENERGY ENGINEERING ANALYSIS PROGRAM
OMAHA DISTRICT CORPS OF ENGINEERS
ROCK ISLAND ARSENAL, ILLINOIS

SUMMARY OF PROJECTS

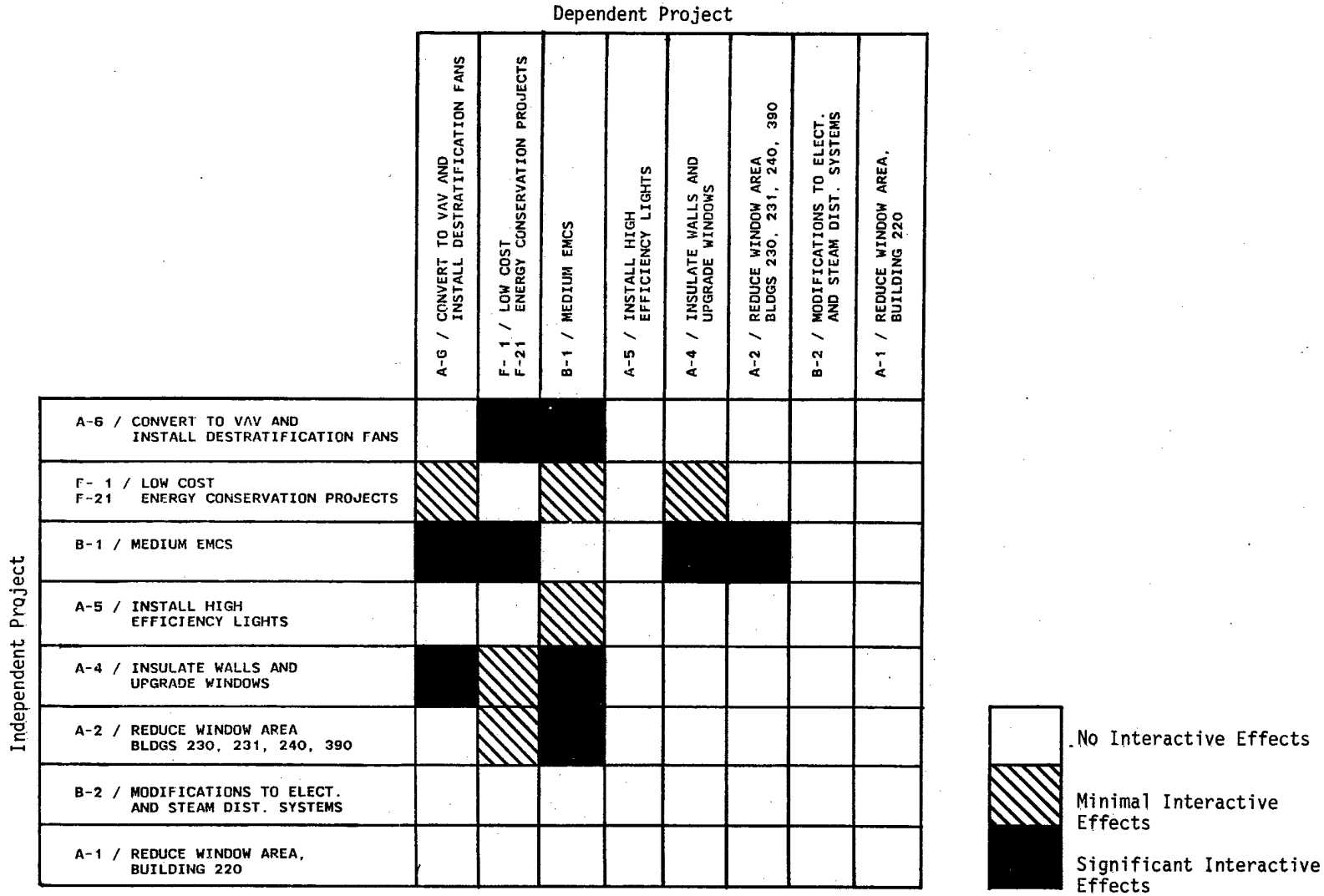
PROJECT TITLE	ANNUAL ENERGY SAVINGS					DOLLAR SAVINGS ($1000'S)		COST ($1000'S FY86)		ECIP RATIOS		
	ELECT. (KWH)	NAT.GAS (KCF)	COAL (TONS)	FUEL OIL (GAL)	TOTAL (MBTU)	ANNUAL (FY86)	TOTAL BENEFIT	CWE	TIC	E/C	B/C	PAY BACK
ECIP QUALIFYING PROJECTS:												
A-6 / CONVERT TO VAV & DESTRAT. FANS	1190000.	0.	944.7	1573.	37244.	163.9	1961.9	391.4	410.6	95.1	4.8	2.4
F-1 / F-21 LOW COST ENERGY CONSERVATION PROJECTS	148965.	1802.	624.6	1133.	19096.	76.4	957.0	227.1	238.2	84.1	4.0	3.0
B-1 / MEDIUM EMCS	5516216.	0.	3178.1	14620.	144140.	655.1	8044.8	1772.0	1859.0	81.3	4.3	2.7
A-5 / INSTALL HIGH EFFICIENCY LIGHTS	1364474.	0.	-194.2	0.	11056.	86.4	1087.1	153.4	160.9	72.1	6.8	1.8
A-4 / INSULATE WALLS & UPGRADE WINDOWS	42845.	112.	675.0	2540.	17571.	70.0	1093.4	371.9	390.2	47.2	2.8	5.3
A-2 / RED. WINDOW AREA BLDGS 230,231, 240 & 390	0.	0.	1063.0	0.	26138.	97.2	1437.1	816.9	857.0	32.0	1.7	8.4
B-2 / MOD. TO ELECT. & STEAM DIST. SYS.	109500.	0.	1165.0	0.	29911.	115.0	1254.0	1157.9	1159.8	25.8	1.1	10.1
A-1 / RED. WINDOW AREA BUILDING 220	0.	0.	2162.2	0.	53147.	197.9	2924.0	2452.6	2584.7	21.7	1.1	12.4

TABLE 8 (Con't.)
ENERGY ENGINEERING ANALYSIS PROGRAM
OMAHA DISTRICT CORPS OF ENGINEERS
ROCK ISLAND ARSENAL, ILLINOIS

SUMMARY OF PROJECTS

PROJECT TITLE	ANNUAL ENERGY SAVINGS					DOLLAR SAVINGS ($1000'S)		COST ($1000'S FY86)		ECIP RATIOS		
	ELECT. (KWH)	NAT.GAS (KCF)	COAL (TONS)	FUEL OIL (GAL)	TOTAL (MBTU)	ANNUAL (FY86)	TOTAL BENEFIT	CWE	TIC	E/C	B/C	PAY BACK
NON ECIP QUALIFYING PROJECTS:												
G-1 / NON-QUALIFYING ECOS FOR BLDGS.	-77519.	245.	1981.0	719.	48150.	53.8	1155.9	4627.3	4854.3	10.4	0.2	86.0
G-5B/ CONSOL. CLG. SYS. BLDG.350(CASE II)	83815.	0.	45.8	0.	2098.	24.6	295.3	552.3	579.4	3.8	0.5	22.5
G-6 / INC. ELEC. LOAD SHED. CAPABILITY	0.	0.	0.0	0.	0.	21.8	267.6	71.0	74.4	0.0	3.6	3.3
G-3 / ELEC. SUBMETERING OF SELECTED BLDGS	0.	0.	0.0	0.	0.	0.0	0.0	29.5	29.5	0.0	0.0	NONE
G-4 / STEAM SUBMETERING OF SELECTED BLDGS	0.	0.	0.0	0.	0.	0.0	0.0	51.1	51.1	0.0	0.0	NONE
G-2 / ELECTRIC POWER FACTOR CORRECTION	0.	0.	0.0	0.	0.	0.0	0.0	-	-	0.0	0.0	NONE
G-5A/ CONSOL. CLG. SYS. BLDG.350 (CASE I)	331672.	0.	-206.6	0.	-1231.	46.4	598.2	639.4	670.8	-1.9	0.9	13.8

TABLE 9
EFFECT OF INTERACTIONS BETWEEN PROJECTS ON ENERGY SAVINGS



then categorized as "none", "minimal", or "significant". All of the projects which presently qualify for ECIP funding would still meet ECIP criteria even if interactive effects on energy savings were taken into account.

Energy Goals and Projected Site Energy Usage

According to the recent DEIS reports, FY75 energy consumption at Rock Island Arsenal totalled 1,517,044 MBTU. In order to meet the goal of 25% reduction in energy consumption by FY85 compared to FY75, established by the Army Facilities Energy Plan, the level of energy consumption at RIA must be reduced to 1,137,783 MBTU/YR by October 1984.

Rock Island Arsenal had decreased its consumption level to 1,246,717 MBTU/YR by FY81, a reduction of 17.8% compared to FY75. A major setback in meeting the FY75 energy goals was suffered in FY82, when increased production caused energy consumption to increase to 1,390,978 MBTU/YR. Several major construction projects, e.g., air conditioning administration buildings and boiler plant pollution control systems, will be completed in the near future and are expected to further increase energy consumption by 52,549 MBTU/YR to a new level of 1,443,527 MBTU/YR by FY85.

Implementation of all recommended projects summarized in Table 8 appears to be the most promising alternative for achieving further reductions in energy consumption. Realization of the 338,000 MBTU/YR total savings for the projects which qualify for ECIP funding would bring RIA's consumption level to 1,105,527 MBTU/YR, which is below the target of 1,137,783 MBTU/YR. The actual savings will be somewhat less due to interactions between projects but still should allow RIA to meet its target consumption level.

ECIP funding for the projects generated under this study will not be available until FY86 and it will probably be three to four years after that

time before all of the qualifying projects are funded. For this reason it appears that Rock Island Arsenal will be able to reduce its energy consumption by 25% using FY75 as a base year but will be four to five years late in meeting its FY85 goal.

Figure 4 depicts RIA energy consumption for the period FY75 to FY82 based upon the DEIS reports. Future energy consumption was then projected by adding the anticipated effects of new construction and implementation of ECIP projects to the FY82 level of consumption.

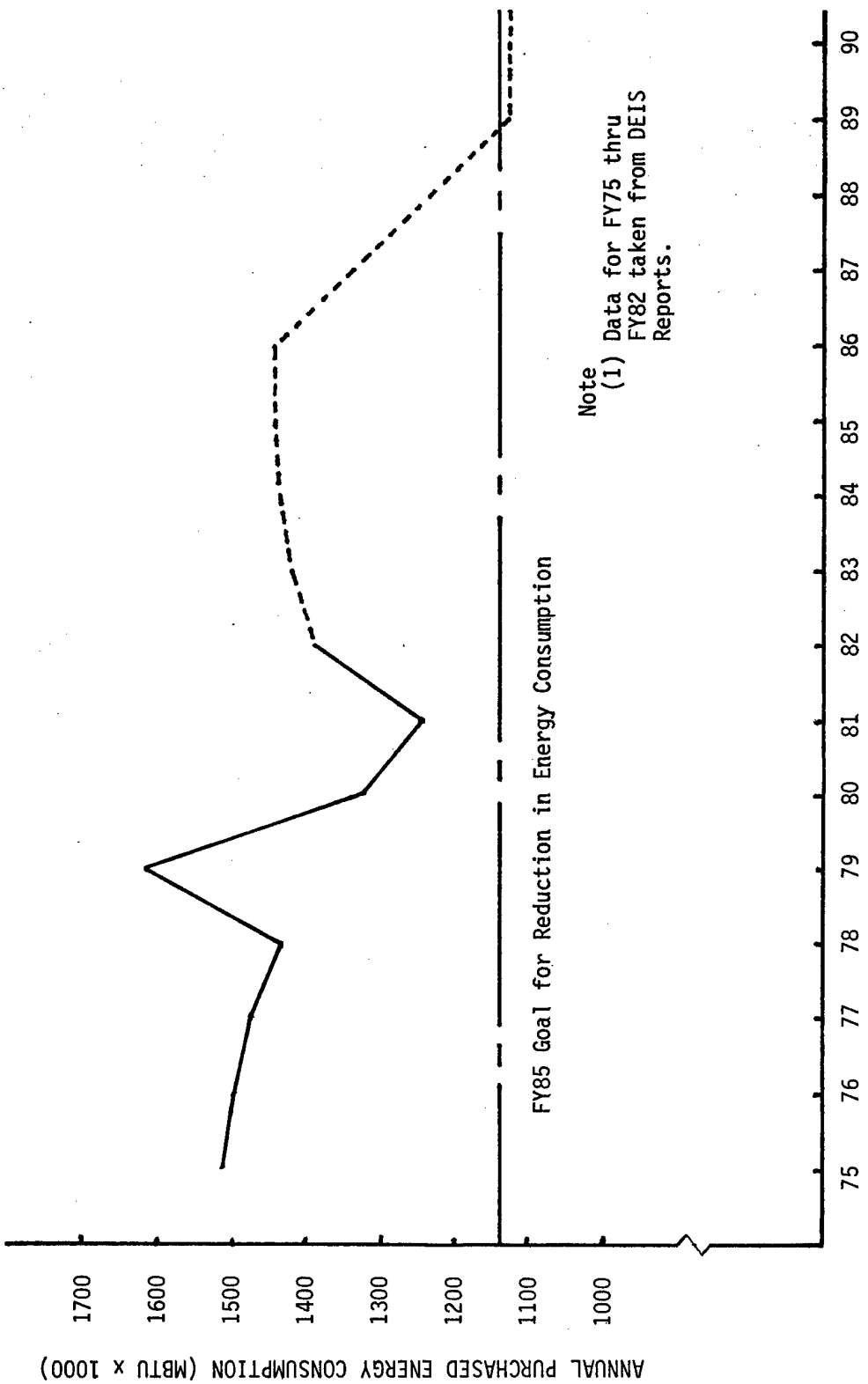


Figure 4 PROJECTED RIA ENERGY CONSUMPTION